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TAXONOMIC STATUS OF THE "SOUTHWESTERN" STOCKS OF SPINNER DOLPHIN, STENELLA LONGIROSTRIS, AND SPOTTED DOLPHIN, S. ATTENUATA

by

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At the time of the Porpoise Stock Assessment Workshop convened at La Jolla in August 1976 (SWFC, 1976), sketchy information was available for both S. longirostris and S. attenuata suggesting that animals observed south of the equator and west of the Galápagos Islands are morphologically different from those to the north and east. Pending further study, these tentatively identified "Southwestern stocks" were provisionally lumped with the offshore stocks of the respective species for assessment. The purpose of this report is to present the results of study of series of "Southwestern" spotted and spinner dolphins, with recommendations for partition of management units in the two species in the eastern Pacific.

SPINNER DOLPHIN

Background

The first indications of existence of a "different kind of spinner" south of the equator came from observations by W.E. Evans and D.W. Rice on the U.S.-U.S.S.R. cooperative whale-tagging cruise of the Vnushitel'nyi in early 1975. They sighted several schools of spinner dolphins during the cruise (Fig. 1) and were struck by the different coloration of animals seen south of the Galápagos. Both had also had extensive prior field experience with spinners north of the equator. Following is an

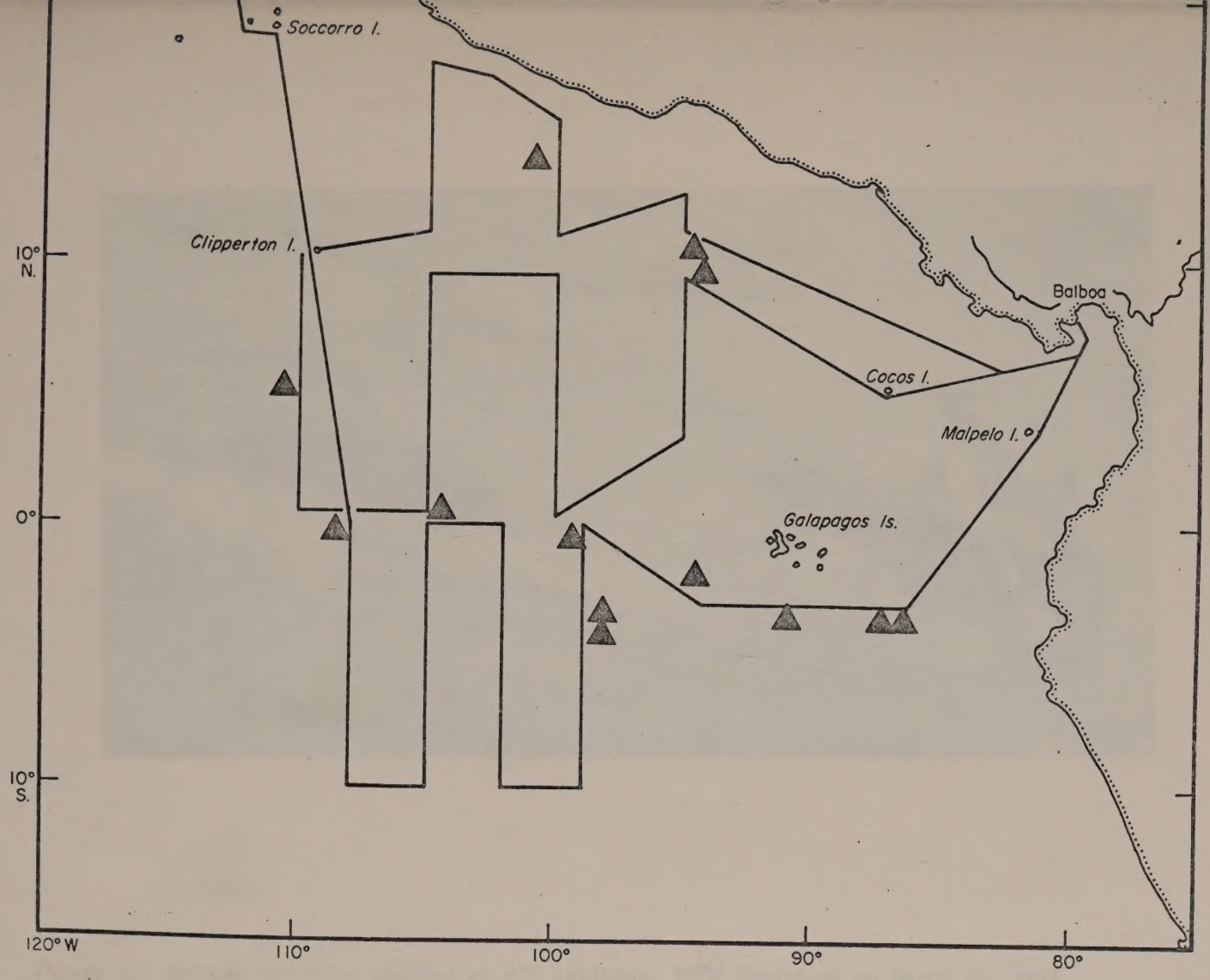


Figure 1. Sighting of S. longirostris during the cruise of the Vnushitel'nyi, February to April 1975.

Figure 2. Spinner dolphins sighted at 4°S latitude, 99°W longitude on March 13, 1975.
Photo by W.E. Evans

excerpt from Rice's field journal describing animals seen at about 4°S latitude, 99°W longitude on March 13, 1975:

> "These animals resembled Hawaiian spinner porpoises in their three-tone color pattern, but had shorter beaks. The lateral gray area was somewhat darker immediately adjacent to the sharply defined white belly, giving the appearance of a faint lateral stripe. The dorsal fins were high and triangular--even slightly canted forward on some of the larger ones. The animals appeared to have dark-tipped snouts and eye-to-eye flipper stripes."

Field sketches by both Evans and Rice and a photograph by Evans (Fig. 2) all show the ill-defined lateral stripe described by Rice and not seen by these or other observers as part of the color pattern of "whitebelly spinners" to the north.

The unusually marked spinner dolphins were seen again in February 1976 during a survey cruise of the David Starr Jordan (Fig. 3), at three locations south of the Galápagos. Following is an excerpt from sighting notes for February 15, 1976 by William A. Walker (an observer with prior experience aboard a commercial tuna seiner):

> These animals more closely resemble Hawaiian stock, than those in vicinity of Clipperton [Island]. Lateral overlay of cape gives an almost stripe like effect running from eye to vent, . . .

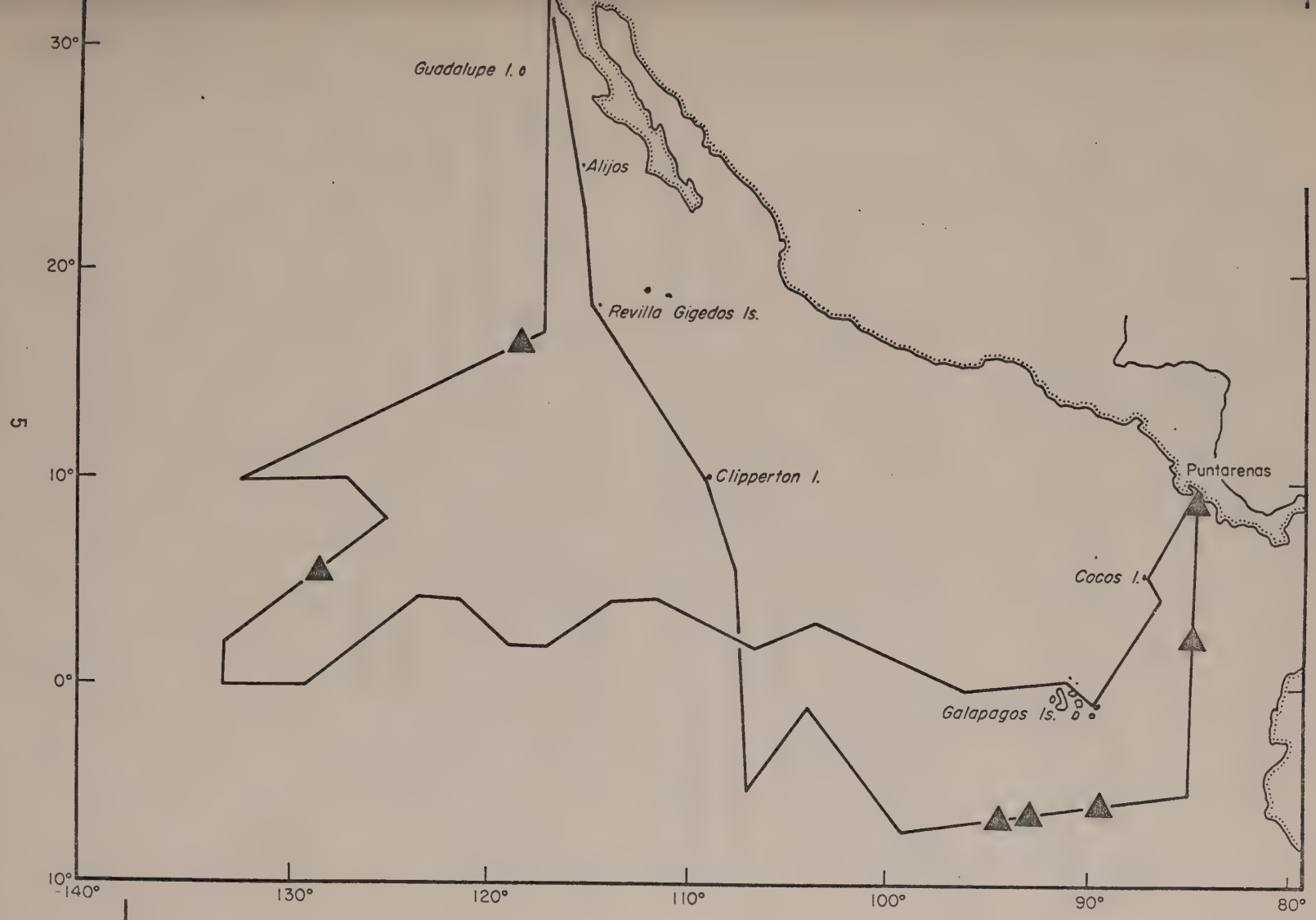


Figure 3. Sightings of Stenella longirostris during cruise of David Starr Jordan, January 5 to March 2, 1976

The border of the cape and lateral white field was distinct on these porpoise. No mottling was evident."

The summary report for the cruise (Cruise J-76-1 (100), Porpoise Cruise No. 169) stated concerning the seven sightings of S. longirostris during the cruise:

"Four of the seven schools were classified as whitebelly spinners. All of these observations were slightly outside the historically understood boundaries. However, the three observations made at about 05°-06°S appear, from color pattern differences, to be a separate stock from those normally encountered in the far offshore waters from approximately 800 km offshore to 140°W longitude."

The observations from the cruises of the Vnushitel'nyi and the D. S. Jordan constituted the information available to the Porpoise Stock Assessment Workshop in August 1976, and were the basis for provisionally considering a "tentatively identified southwestern stock" (NMFS, 1977). Specimens collected south of the equator subsequently became available and allowed further evaluation of the "southwestern stock."

Morphological Analyses

Treatment of morphological specimens. Fifteen frozen carcasses of S. longirostris from south of the equator and west of 90° longitude were available for study (Table 1). They were collected by NMFS observers during seining operations in early 1976. The specimens were thawed in water, weighed to the nearest pound on a platform balance, and photographed in color. External measurements were taken with a large set of calipers with adjustable jaws. Long measurements were taken parallel to the long axis of the body. The carcasses were then fleshed sufficiently far to allow vertebral counts to be made. The terminal 20-30 cm of the vertebral column was severed and x-rayed to determine the number of vertebrae. The flippers were also detached and x-rayed for phalangeal counts. The skulls were fleshed, sun-dried, and cleaned with dermestid beetles. Skull measurements were taken as described by Perrin (1975). After measurement, the skulls were placed in the marine mammal collection of the Museum of Comparative Zoology, Harvard University, Cambridge, Mass. The postcranial skeletons were not saved.

In addition to the extensive data from the 15 whole specimens, a lesser set of data was available for 118 adult specimens (61 males and 57 females) examined at sea in the area south of the equator and west of 90°W longitude (Fig. 4). These data included total length, reproductive

Table 1. Collection data for whole frozen specimens of *S. longirostris* from below the Equator and west of 90°W longitude. Museum of Comparative Zoology (MCZ) number in parentheses

Specimen No.	Locality (Lat/Long)	Date	Sex	Length (cm)
1. DBF 010 (57240)	4°00'S/94°25'W	30 Oct. 76	F	180
2. DBF 011 (57241)	"	"	M	170
3. DBF 012 (57242)	"	"	F	177
4. DBF 013 (57243)	"	"	M	183
5. DBF 017 (57244)	5°05'S/94°26'W	31 Oct. 76	M	183
6. DBF 020 (57245)	"	"	M	182
7. DBF 024 (57246)	"	"	F	170
8. DBF 026 (57247)	"	"	M	182
9. DBF 031 (57248)	"	"	F	187
10. DBF 035 (57249)	"	"	M	181
11. DBF 036 (57250)	"	"	M	188
12. DBF 038 (57251)	5°25'S/92°33'W	4 Nov. 76	M	186
13. DBF 040 (57252)	"	"	F	175
14. DBF 042 (57253)	3°41'S/92°36'W	6 Nov. 76	F	187
15. DBF 043 (57254)	"	"	F	177

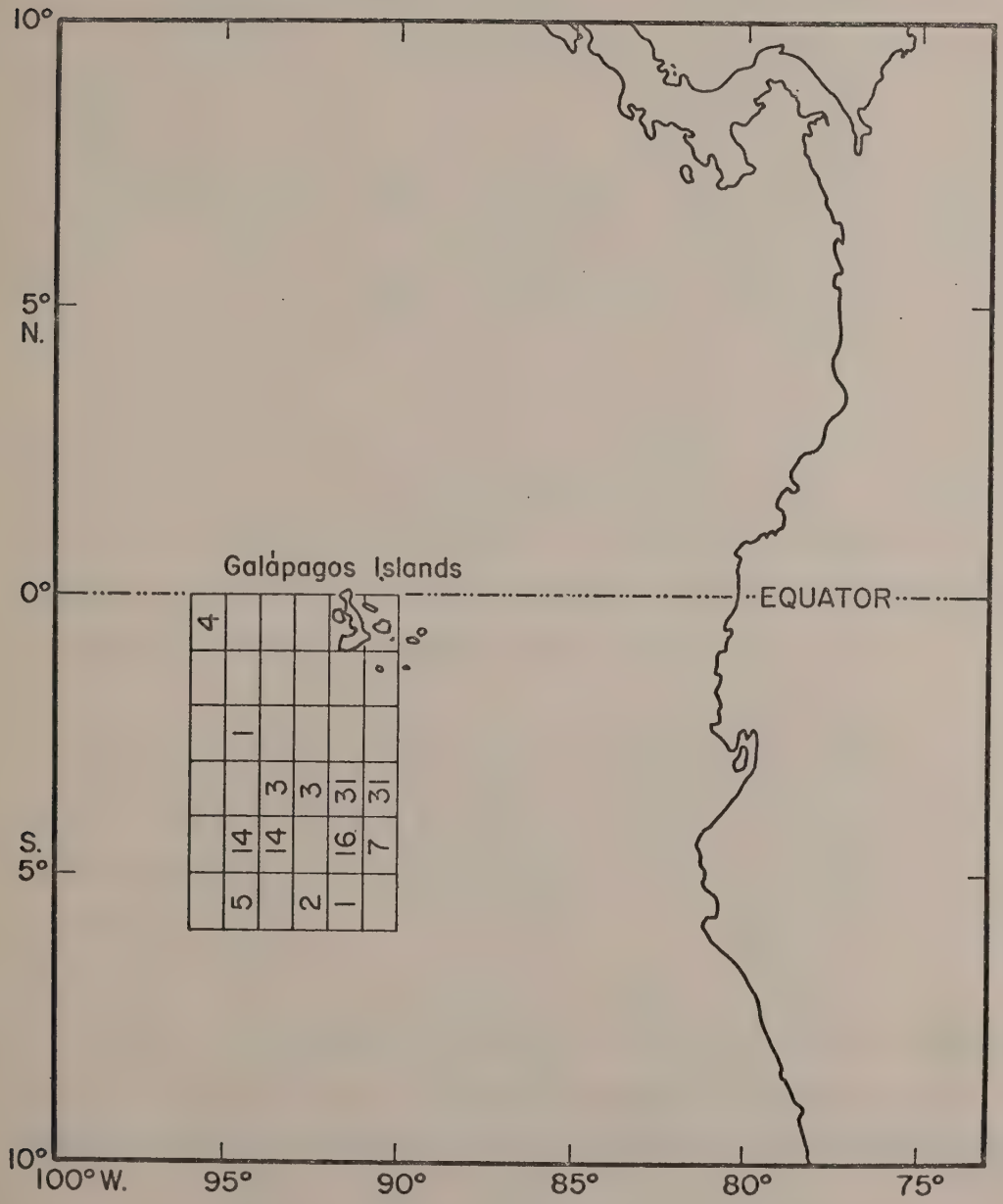


Figure 4. Collection localities of 132 adult specimens of S. longirostris used in analysis of total length.

condition (weight of testes for males; uterine, ovarian and lactation data for females), and, in some cases, field sketches and photographs.

Results

Color pattern. The modal color pattern (Fig. 5) indeed more resembles that of spinner dolphins from around Hawaii than that of the whitebelly spinner dolphin as described from north of the equator (Perrin, 1973), in two respects:

1) the dorsal overlay is sufficiently light that the dorsal cape shows through distinctly, yielding a pronounced tripartite pattern, as opposed to a basically two-part pattern in the northern whitebelly form yielded by a more dense dorsal overlay, and

2) the ventral margin of the dorsal overlay is relatively sharp and smooth, as compared to a usually more diffuse margin in the typical whitebelly spinner, again emphasizing the three-part character of the pattern.

The reported lateral stripe turns out not to be an actual stripe, but an increase in density of the dorsal overlay toward its ventral margin. On close inspection the animal does not have a defined stripe,

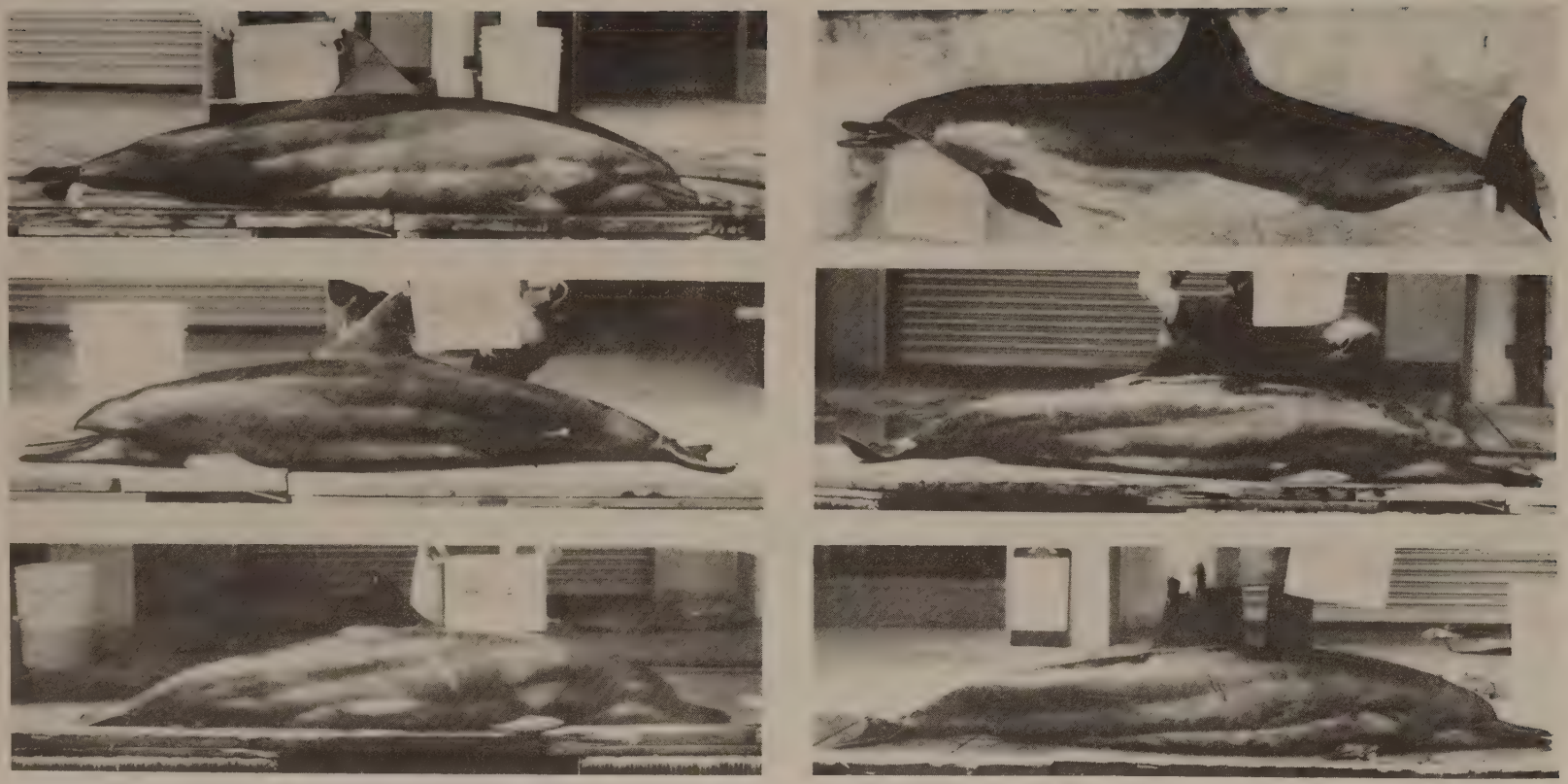


Figure 5. External appearance (after freezing and thawing) of spinner dolphins from below the equator and west of 90°W longitude

but in the water it appears striped. Again, the appearance is quite like that of many Hawaiian spinners in this respect (Fig. 6).

The color pattern differences between this animal and the whitebelly spinner to the north are modal differences, and do not occur with the same intensity for every animal in the population. As is the case for other characters varying in this manner geographically within a species, some individuals from either of the adjacent areas (north or south of the equator) most resemble typical animals from the other area. For example, some of the 15 individuals examined here (no. DBF 026 in Fig. 5, for one) had a more dense dorsal overlay with a less-emphasized ventral margin than the others and appeared more "whitebelly-like." Some spinners sighted in the far-western reaches of the whitebelly range exhibit the Hawaiian/"southwestern" color pattern (Fig. 7).

External size and shape. Both males and females (Fig. 8) are on the average 2-3 cm longer than whitebelly spinners (Table 2 and Fig. 13 in Perrin, Holts & Miller, 1976). The samples are large (Fig. 4), and the difference is statistically significant at $\alpha = 0.05$ ($d = 2.171$ for males and 2.574 for females; test for comparing means of two large samples from normal populations--Bailey, 1959). The sample sizes for other external measurements (Table 2) are small, but the means for the southwestern series are greater than those for a similarly sized series of whitebelly spinners (Table 16 in Perrin, 1975) for all the measurements except "tip of snout to blowhole," for which the means are the same. For the two external measurements which most reflect length of the beak,

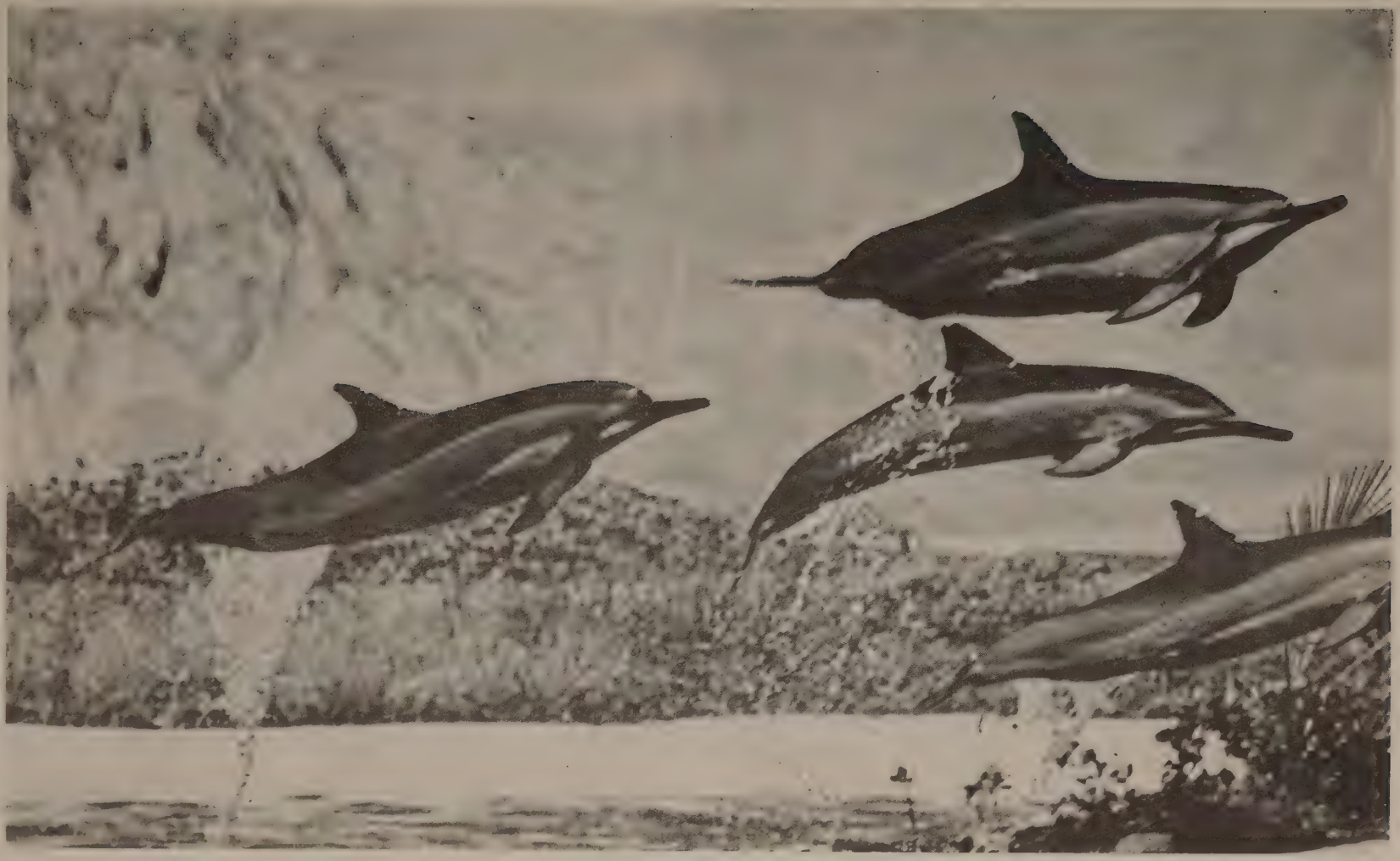


Figure 6. Captive Hawaiian spinner dolphins

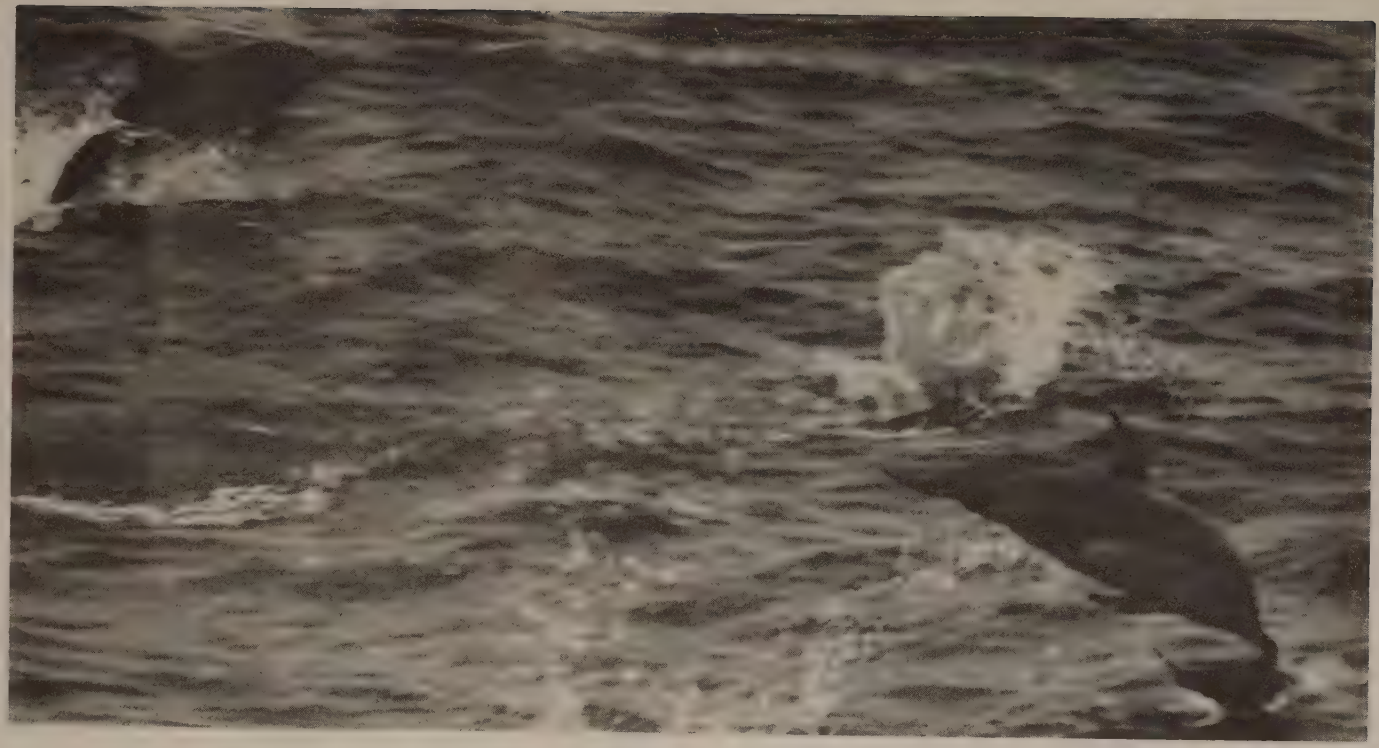


Figure 7. Whitebelly spinner dolphins sighted at 11°35'N latitude, 146°33'W longitude on January 9, 1976.
Photo by G.L. Friedrichsen

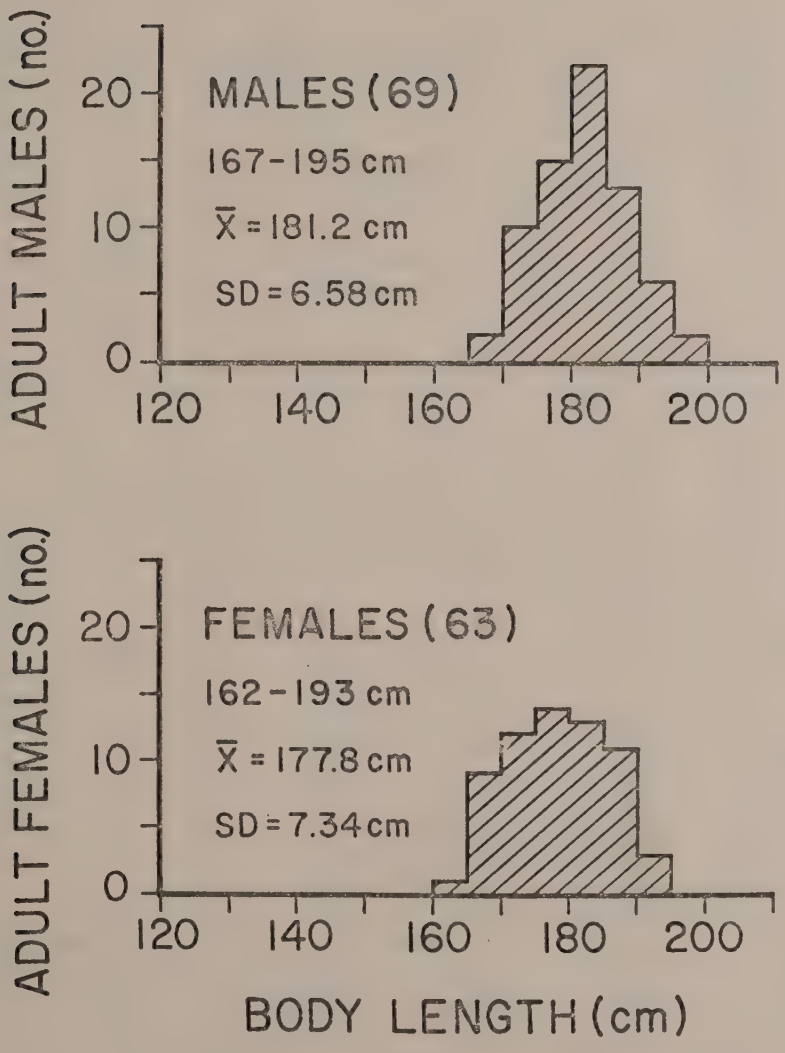


Figure 8. Total length of adult spinner dolphins from south of the equator and west of 90°W longitude.

Table 2. External measurements of sexually mature spinner dolphins, S. longirostris, from south of the equator and west of 90° W. longitude. Measurements (in cm) follow Perrin (1975). Males included have testis weight ≥ 94 g.

Total Length	Sample size	Range	Mean	Standard deviation
(M)	7	170-186	181.0	5.03
(F)	6	175-187	180.3	5.15
Tip of snout to center eye	13	28-33	30.3	1.41
Tip of snout to apex of melon				
(M)	7	13-16	14.8	1.30
(F)	6	14-17	15.2	1.12
Length of gape	13	24-30	26.2	1.53
Tip of snout to blowhole	12	25-33	29.4	2.27
Tip of snout to anterior insertion of flipper	13	40-44	41.6	1.08
Tip of snout to tip of dorsal fin				
(M)	7	98-104	100.4	2.28
(F)	6	99-109	104.6	4.39
Tip of snout to umbilicus	13	84-95	88.8	3.81
Girth at axilla				
(M)	7	78-90	83.6	4.53
(F)	6	80-87	88.3	2.50
Flipper length to axilla	13	18-22	20.7	1.12
Fluke span				
(M)	7	37-45	41.3	3.36
(F)	6	36-41	38.5	2.07

that is, "Tip of snout to apex of melon" and "Length of gape," the ranges for the series fall below the ranges for small series of Hawaiian spinners, but for the remaining measurements the ranges overlap considerably, suggesting that while the "southwestern spinner," like the Hawaiian spinner, is on the average larger than the whitebelly spinner, its beak is not proportionately as long as that of the Hawaiian spinner, a finding consonant with the above-cited field observations.

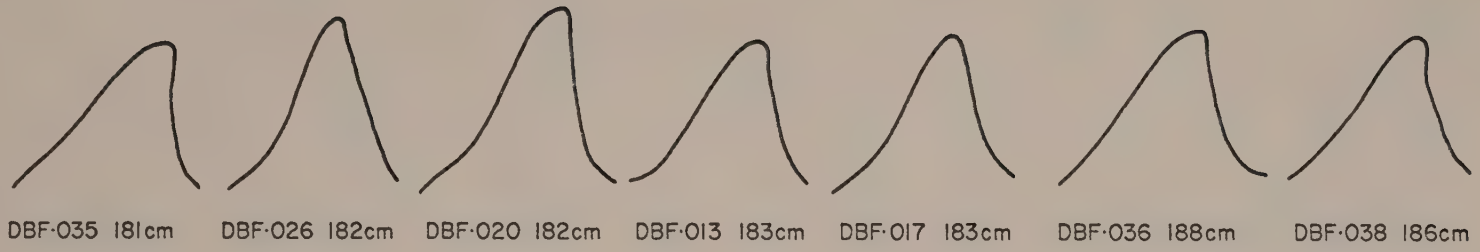
The dorsal fin (Fig. 9) is sexually dimorphic but highly variable and not significantly different from that of the whitebelly spinner (Perrin 1975).

Skeleton. The means for nearly all the skull measurements (Table 3) fall between the means for whitebelly and Hawaiian spinners (Table 19 in Perrin, 1975). The exceptions are "Premaxillary width at rostrum midlength" and "Internal nares width," for which the "southwestern" means exceed the Hawaiian means. The "southwestern" skulls fall between the whitebelly series and Hawaiian series in shape as well as size, as shown by a scatterplot (Fig. 11) on two orthogonal discriminant axes based on all 25 measurements for Costa Rican, eastern, and whitebelly series (loading coefficients in Perrin, 1975).

SPOTTED DOLPHIN

Background

Only one school of spotted dolphins was seen south of the equator during the cruise of the Vnushitel'nyi, at 00°52'S latitude, 98°44'W



MALES

FEMALES

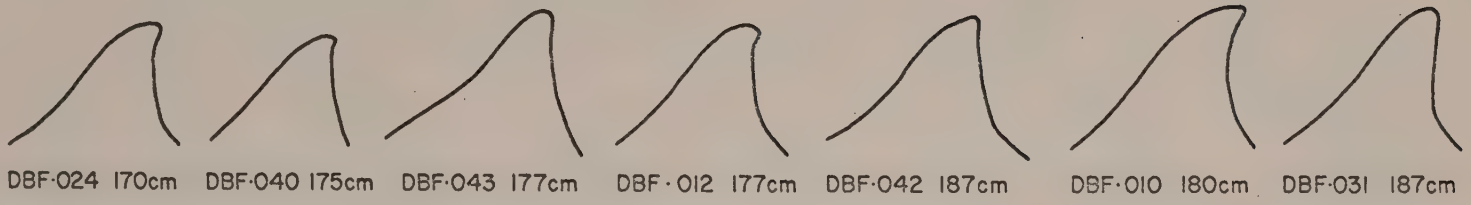


Figure 9. Dorsal fins of male (upper) and female (lower) spinner dolphins from south of the equator and west of 90°W longitude. Specimen nos. and length (cm) given.

Table 3. Skeleton measurements (in mm) and meristics of spinner dolphins, S. longirostris, from south of Equator and west of 90°W longitude. Numbering system follows Perrin (1975). Sample for meristics includes all specimens, sample for measurements includes sexually mature specimens (using criterion of distal fusion of maxillaries and premaxillaries).

Variable	Sample	Range	Mean	Standard deviation
1. Condylobasal length	12	398-438	415.8	11.86
2. Rostrum length	12	250-278	265.3	10.36
3. Rostrum width at base	14	71-83	76.4	3.00
4. Rostrum width at 60 mm	14	51-60	53.4	3.56
5. Rostrum width at midlength	11	41-51	42.3	2.70
6. Premaxillary width at rostrum midlength	12	17-23	20.8	1.89
7. Rostrum width at 3/4 length	12	29-36	32.0	2.17
8. Rostrum tip to external nares	12	287-318	304.3	10.19
9. Rostrum tip to internal nares	12	291-327	308.2	10.76
0. Preorbital width	14	138-150	143.6	3.81
1. Postorbital width	14	154-167	159.6	4.10
2. Least supraorbital width				
3. External nares width	14	38-46	42.1	2.24
4. Zygomatic width	14	156-165	158.1	4.36
5. Greatest width of premaxillaries	14	60-67	63.9	2.44
6. Parietal width	14	123-139	130.4	5.04
7. Braincase height	14	86-98	90.3	3.64
8. Braincase length	14	102-113	105.2	3.42
9. Posttemporal fossa length	14	41-56	49.9	4.31
0. Posttemporal fossa width	14	37-45	41.3	2.12
5. Orbit length	14	39-45	40.7	1.48
6. Internal nares width	14	44-50	46.4	1.65
2. Upper tooth row length	12	208-246	229.0	10.62
3-36. Teeth (no.) U.L. | U.R.	13 13	46-59 49-59	53.1 53.5	4.05 3.50
L.L. | L.R.	15 12	44-59 46-58	51.1 51.9	4.26 4.23
7. Lower tooth row length	14	193-236	221.6	11.79
8. Ramus length	14	322-374	351.4	13.34
9. Ramus height	14	51-60	55.2	2.32
8. Thoracic vertebrae (no.)	15	15-17	16.1	0.59
9. Lumbar vertebrae (no.)	15	16-18	16.5	0.63
0. Caudal vertebrae (no.)	15	32-38	34.5	1.40
1. Total vertebrae (no.)	15	72-77	74.1	1.24

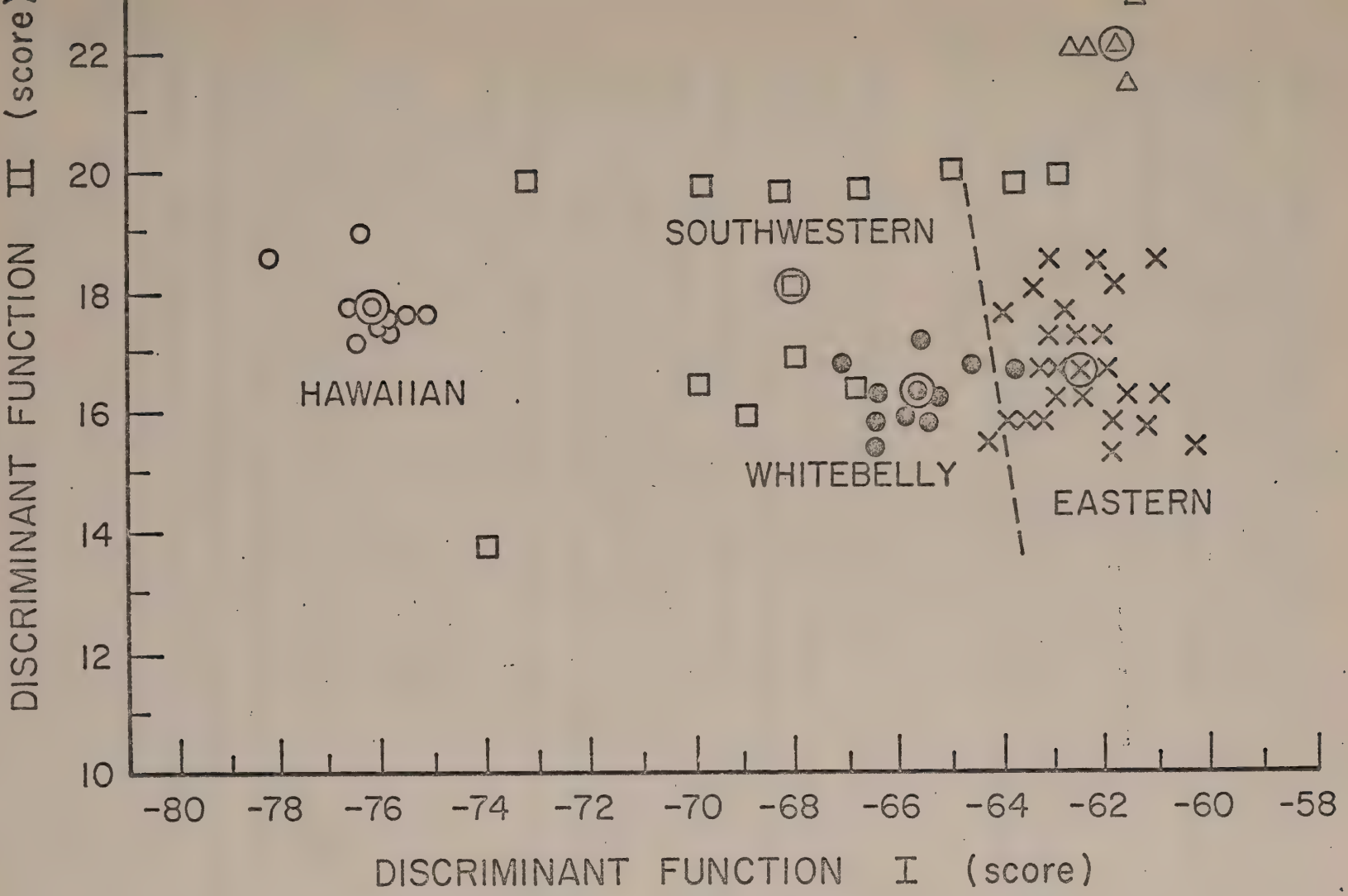


Figure 10. Plot of "southwestern" specimens (squares) on two discriminant axes based on 25 skull measurements (discriminant functions in Perrin, 1975). Circled symbols are group means.

latitude, 98°44'W longitude. These animals had an overall lighter color pattern, with more contrasting elements, and were more lightly spotted than typical spotted dolphins to the north. The field notes for the sighting state.

> "All spotters looked like two-tone or speckled [early coloration growth phases in more northerly spotted dolphins--Perrin, 1970]--cape very visible."

Such coloration is characteristic of spotted dolphins in the far-western regions of the range in the eastern Pacific and around Hawaii (Perrin, 1975). Because of this seemingly parallel situation to that for the spinner dolphin and because of lack of additional data (the David Starr Jordan saw no spotted dolphins below the equator during the 1976 cruise), spotted dolphins involved in seining operations south of the Galápagos in early 1976 were considered by the Porpoise Stock Assessment Workshop in a provisional "southwestern stock" like that erected for the spinner dolphins.

Morphological Specimens

Nineteen whole carcasses (six males and 13 females) were available for study, from two localities southwest of the Galápagos (Table 4). Treatment was the same as for the specimens of S. longirostris. Total-length and color pattern data were available for 34 additional adult

Table 4. Collection data for whale frozen specimens of S. attenuata from below the equator and west of 90°W longitude. Museum of comparative zoology number in parentheses.

Specimen No.	Locality (Lat/Long)	Date	Sex	Length (cm)
1. DBF 014 (57257)	5°05'S/94°26'W	31 Oct. 76	F	171
2. DBF 015 (57258)	"	"	F	186
3. DBF 016 (57259)	"	"	M	176
4. DBF 018 (57260)	"	"	F	188
5. DBF 019 (57261)	"	"	F	188
6. DBF 021 (57262)	"	"	F	190
7. DBF 022 (57263)	"	"	F	189
8. DBF 023 (57264)	"	"	M	183
9. DBF 025 (57265)	"	"	F	188
10. DBF 027 (57266)	"	"	M	173
11. DBF 028 (57267)	"	"	F	179
12. DBF 029 (57268)	"	"	F	189
13. DBF 030 (57269)	"	"	M	204
14. DBF 032 (57270)	"	"	M	174
15. DBF 033 (57271)	"	"	F	177
16. DBF 034 (57272)	"	"	F	191
17. DBF 037 (57273)	5°25'S/92°33'W	4 Nov. 76	F	170
18. DBF 039 (57274)	"	"	F	187
19. DBF 040 (57275)	"	"	M	193

males and 78 adult females examined at sea (Fig. 11). Testis samples were not collected for the males examined at sea, so an approximate criterion of adulthood of 170 cm total length was used for inclusion in the sample of "adult" animals here.

Results

Color pattern. Of the 11 specimens with "adult" coloration (defined in Perrin, 1970), one (9%) showed heavy dorsal spotting, six (55%) had medium spotting, and four (36%) had sparse spotting. This distribution is similar to that in spotted dolphins from the far-offshore portion of the range in the eastern Pacific (Perrin, 1975). They were generally more heavily spotted, however, than animals from around Hawaii.

External size and shape. Spotted dolphins south of the equator are on the average about 2 1/2 cm shorter than those to the north. Not enough gonadal specimens have been collected to allow comparison of means for sexually mature adult males, but 91 sexually mature "south-western" females (Fig. 12) averaged 184.8 cm, as opposed to 187.2 cm (range 165-211, SD 7.12) for 2433 "offshore" females from north of the equator (unpublished data). This difference is significant at $\alpha = 0.001$. Despite this overall lesser size, several anterior external measurements (Table 5), especially that of "Tip of snout to anterior

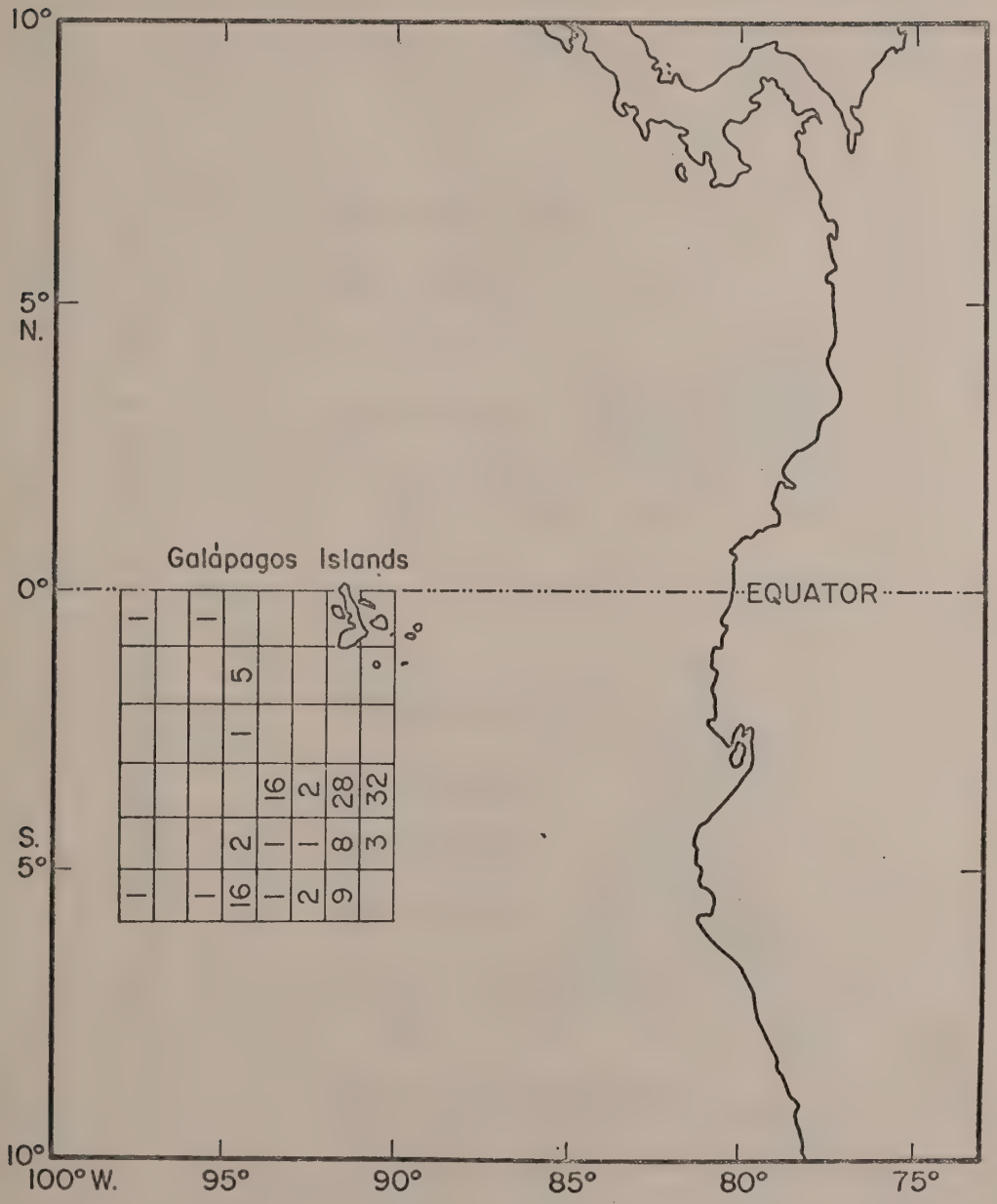


Figure 11. Collection localities of 131 adult specimens of S. attenuata used in analysis of total length.

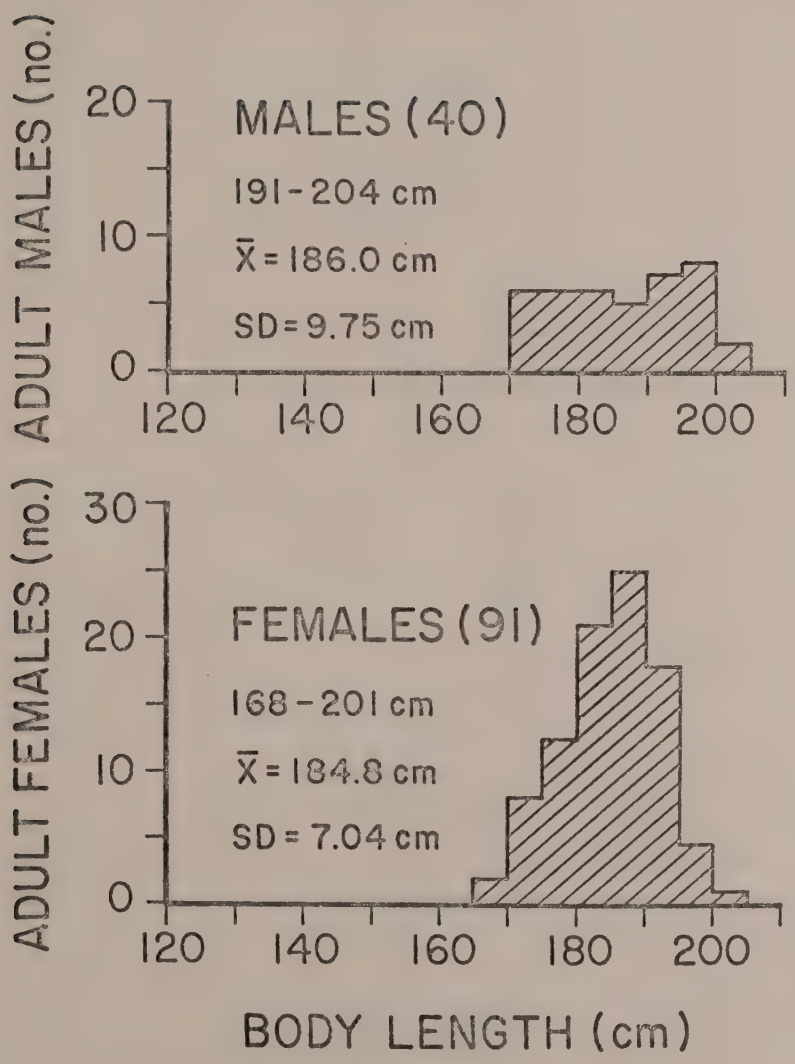


Figure 12. Total length of adult spotted dolphins from south of the Equator and west of 90°W longitude.

Table 5. External measurements (in cm) of adult spotted dolphins from south of the Equator and west of 90° W. longitude. Males with testis weight greater than 100 g. included (Perrin, Coe and Zweifer, 1976).

	Sample size	Range	Mean	Standard deviation
Total length				
(M)	2	193-204		
(F)	13	169.8-190.9	184.1	7.27
Tip of snout to center of eye	15	25.0-28.4	27.2	0.86
Tip of snout to apex of melon				
(M)	2	8.4-10.8		
(F)	13	9.0-11.8	10.1	0.76
Length of gape	15	21.2-24.6	23.4	0.87
Tip of snout to blowhole	15	25.1-27.5	26.3	0.70
Tip of snout to anterior insertion of flipper	15	34.7-40.5	38.3	1.63
Tip of snout to tip of dorsal fin				
(M)	2	112.4-117.3		
(F)	13	73.1-111.1	104.3	9.59
Tip of snout to umbilicus	15	80.9-91.6	88.2	3.50
Girth at axilla				
(M)	2	82.5-86.5		
(F)	13	77.0-86.0	82.7	2.86
Flipper length to axilla	15	16.0-21.1	18.1	1.22
Fluke span				
(M)	2	42.0-44.0		
(F)	13	35.5-44.5	40.4	2.21

insertion of flipper" are comparable for specimens from north (Table 6 in Perrin, 1975) and south of the Equator, indicating that the southern animals have proportionately larger heads. This is supported by skull measurements (discussed below).

Skelton. For most skull measurements, the means for the series of "southwestern" specimens (Table 6) falls between those for the more northerly offshore spotted dolphin and the spotted dolphin around Hawaii (Tables 13a and b in Perrin, 1975). The three series do not differ significantly from each other in proportions of the braincase (length, width, and height). For the single feature in which the Hawaiian spotted dolphin is smaller than eastern Pacific spotted dolphins, the posttemporal fossa (length and width), the "southwestern" series is comparable to the Hawaiian form.

A plot of the means of the specimens for two skull indices on a plot including coastal, offshore and Hawaiian series (Fig. 13) indicates that the skulls of the "southwestern" animals are intermediate between the offshore and Hawaiian forms in shape as well as size.

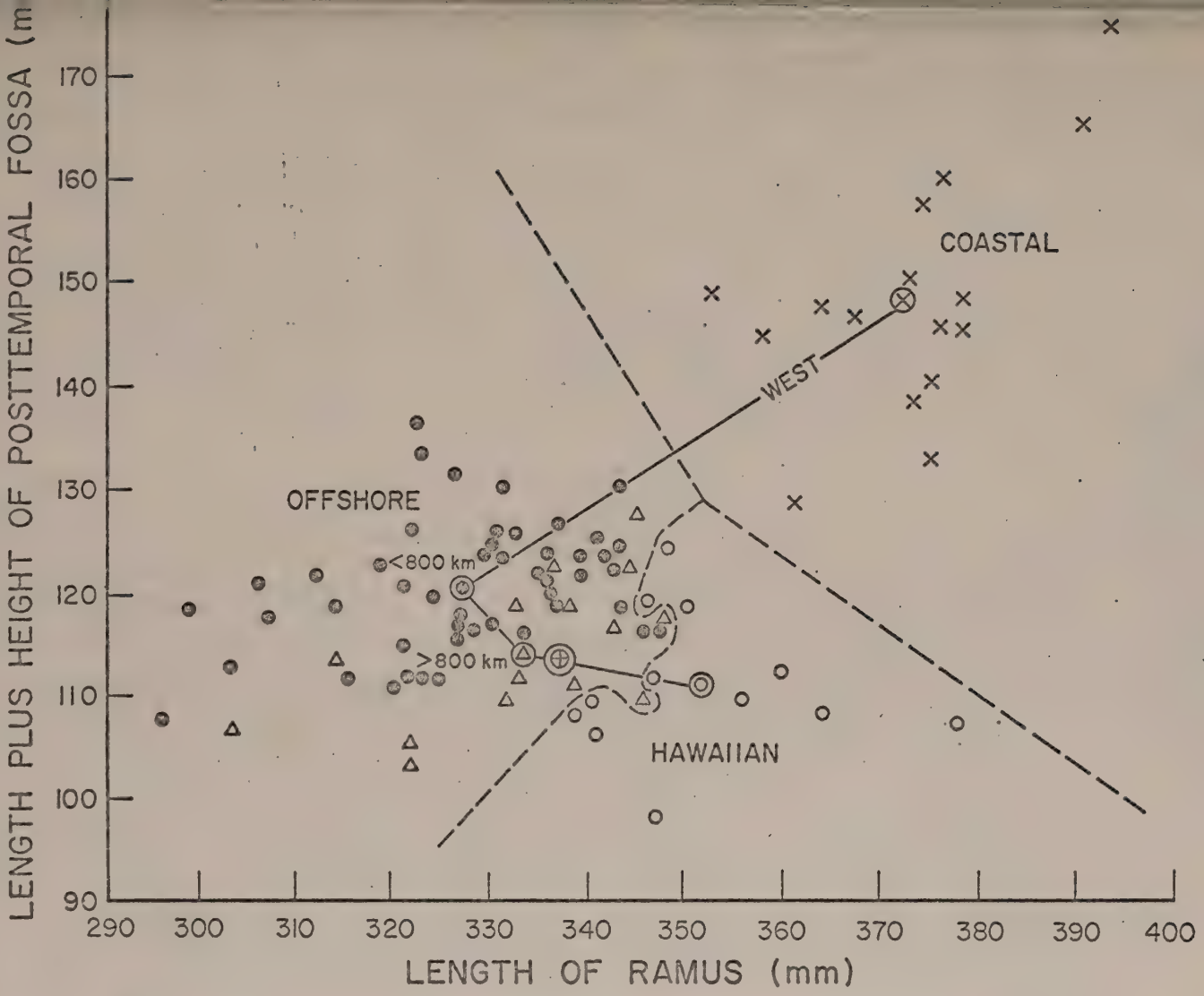


Figure 13. Geographical variation in the skull of the spotted dolphin (from Perrin, 1975), with mean for southwestern series (circled cross). Other sample means circled.

Table 6. Skeleton measurements (m mm) and meristics of adult spotted dolphins, S. attenuata, from south of the Equator and west of 90° W. longitude. Numbering system follows Perrin (1975). Criteria of adulthood as for S. attenuata in Table 3.

Variable	Sample	Range	Mean	Standard deviation
1. Condylobasal length	17	382-414	398.9	8.98
2. Rostrum length	17	228-257	239.8	7.24
3. Rostrum width at base	17	79-91	84.4	3.10
4. Rostrum width at 60 mm	17	54-62	58.2	2.10
5. Rostrum width at midlength	17	38-46	43.8	2.10
6. Premaxillary width at rostrum midlength	17	20-25	23.2	1.33
7. Rostrum width at 3/4 length	16	25-34	29.6	2.22
8. Rostrum tip to extern nares	16	266-295	279.5	8.61
9. Rostrum tip to internal nares	16	270-291	282.3	6.64
10. Preorbital width	17	148-160	152.7	3.83
11. Postorbital width	17	167-178	170.6	3.65
12. Least suporbital width				
13. External nares width	17	40-47	43.1	2.58
14. Zygomatic width	17	166-178	169.8	3.98
15. Greatest width of premaxillary	17	62-73	67.4	2.95
16. Parietal width	17	125-147	137.4	5.62
17. Braincase height	17	89-104	94.1	3.46
18. Braincase length				
(M)	5	110-116	113.8	2.48
(F)	12	103-118	111.2	3.29
19. Posttemporal fossa length	17	59-70	63.9	3.05
20. Posttemporal fossa width	17	45-57	50.6	3.29
25. Orbit length	17	45-50	47.9	1.61
26. Internal nares width	17	46-52	49.1	1.74
32. Upper tooth row length	17	194-221	205.4	6.58
33-36. Teeth (no. $\frac{V.L.|V.R.}{L.L.|L.R.}$	19 19 18 18	38-45 37-45 35-43 36-42	40.2 40.3 38.7 38.6	2.33 2.56 1.97 1.85
37. Lower tooth row length	17	189-219	200.5	7.31
38. Ramus length	17	324-360	338.7	8.30
39. Ramus height	17	54-60	56.3	2.25
48. Thoracic vertebrae (no.)	19	15-17	16.1	0.70
49. Lumbar vertebrae (no.)	19	17-21	19.2	1.08
50. Caudal vertebrae (no.)	19	34-39	36.8	1.34
51. Total vertebrae (no.)	19	78-82	79.1	1.14

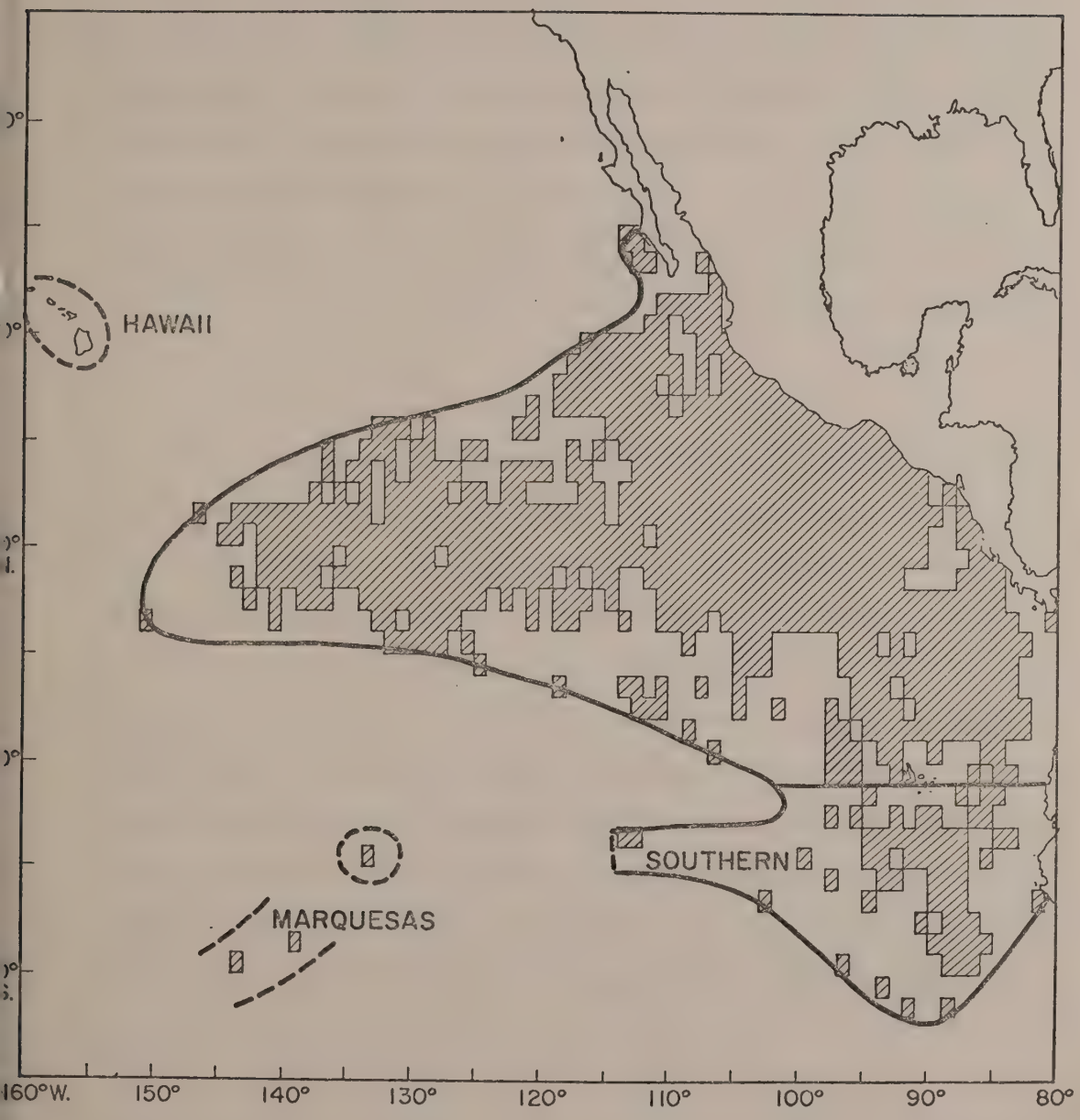


Figure 14. Known range of S. longirostris in the eastern tropical Pacific (unpublished data), with recommended northeast boundary for southern management unit.

Conclusions and Recommendations

The "southwestern" spinner dolphins are clearly modally different from the whitebelly spinners to the north and very much like the spinner dolphins around Hawaii, albeit slightly smaller and with proportionately smaller beaks. This morphological difference leads to the inference that some degree of genetic isolation exists, i.e., that the spinners south of the equator largely belong to a different breeding population than those to the north. This conclusion speaks for separate management units.

While the specimens analyzed here were nearly all collected in the single 5-degree block just southwest of the Galápagos, the distribution of reliable records of S. longirostris (Fig. 14) suggests a range extending south to about 12°S and from near the coast of South America west to at least about 103°W. Spinners observed in January 1977 at 11°30'S latitude, 93°48'W longitude (by Benson Lee, David Starr Jordan cruise 77-1), exhibited the typical "southwestern" color pattern. Sightings further to the west leave open the possibility that the distribution may be continuous with the range of spinner dolphins around the Marquesas Islands and elsewhere in the South Pacific. Specimens from the Marquesas and Tuamotus show affinities to the "southwestern" specimens in that

they are in some characters intermediate between the typical whitebelly and Hawaiian states (Norris, Perrin, Costello, and Bryant, ms).

There is a decrease in density of sightings just below the Galápagos, and a line drawn at 1°S latitude is a reasonable northern boundary for the management unit. Since the range extends east to near the coast of South America, a better name for the unit than "southwestern spinner" is "southern spinner dolphin."

A very similar situation exists for the spotted dolphin. The differences in morphology between the "southwestern" animals and those to the north bespeak some degree of isolation of the southern portion of the distribution and a "southern" management unit is reasonable for this species as well (Fig. 15).

The possibility that the modal differences between the populations in one or both cases are due to differential exploitation (perhaps affecting age and length at maturity) cannot be completely eliminated but is an unlikely one. The size difference relationship is opposite in the two species; for one, the southern form is larger, for the other it is smaller. It is much more likely that the differences are genetically based. Such differences have been encountered in every adequate morphological comparison of populations of small cetaceans (Perrin, 1975).

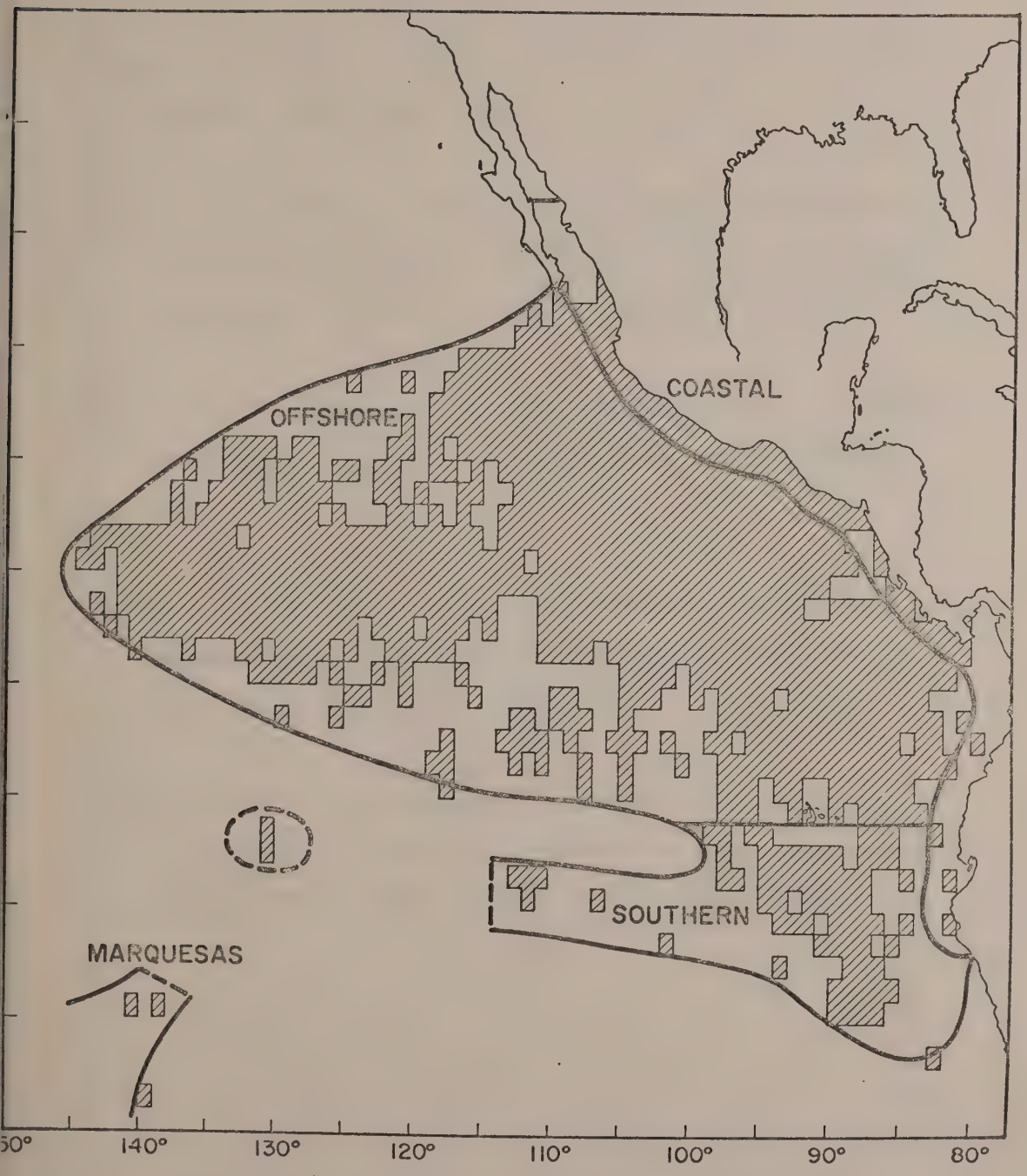


Figure 15. Known range of S. attenuata in the ETP (unpublished data), with recommended northern boundary for southern management unit,

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